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(54) **FIXING STRUCTURE FOR HEAT SOURCE ELEMENT AND HEAT CONDUCTING MEMBER, AND METHOD OF FIXING HEAT SOURCE ELEMENT AND HEAT CONDUCTING MEMBER**

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(52) **U.S. Cl.**
CPC **H05K 7/20154** (2013.01)
USPC **361/710; 257/726**

(58) **Field of Classification Search**
USPC 361/679.46, 679.47, 709, 710; 257/726
See application file for complete search history.

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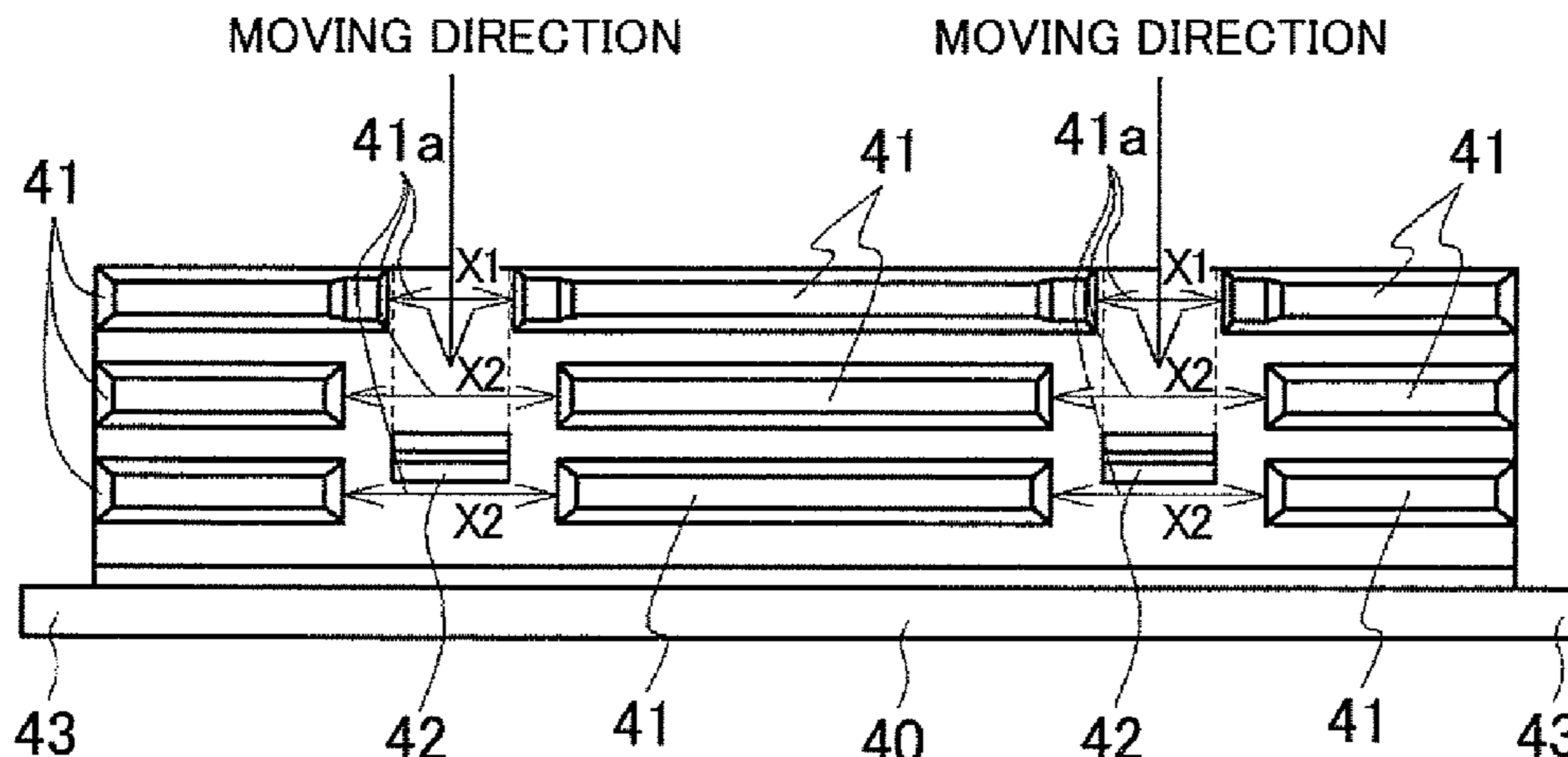
Dec. 13, 2013 Notification of Reason(s) for Refusal issued in Japanese Patent Application No. 2010-268838 (with partial English Translation).

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(57) **ABSTRACT**

An electronic device mounted on a circuit board and accommodated in a housing includes a heat source element accommodated in the housing and mounted on the circuit board, and a heat conducting member accommodated in the housing. The heat conducting member is movably mounted on the circuit board. An elastic member fixes the heat source element and the heat conducting member in abutment with each other. The elasticity of the elastic member permits variations in the relative positions of the heat source element and the heat conducting member while maintaining the abutment of the heat source element and the heat conducting member.

16 Claims, 6 Drawing Sheets



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FIG. 1

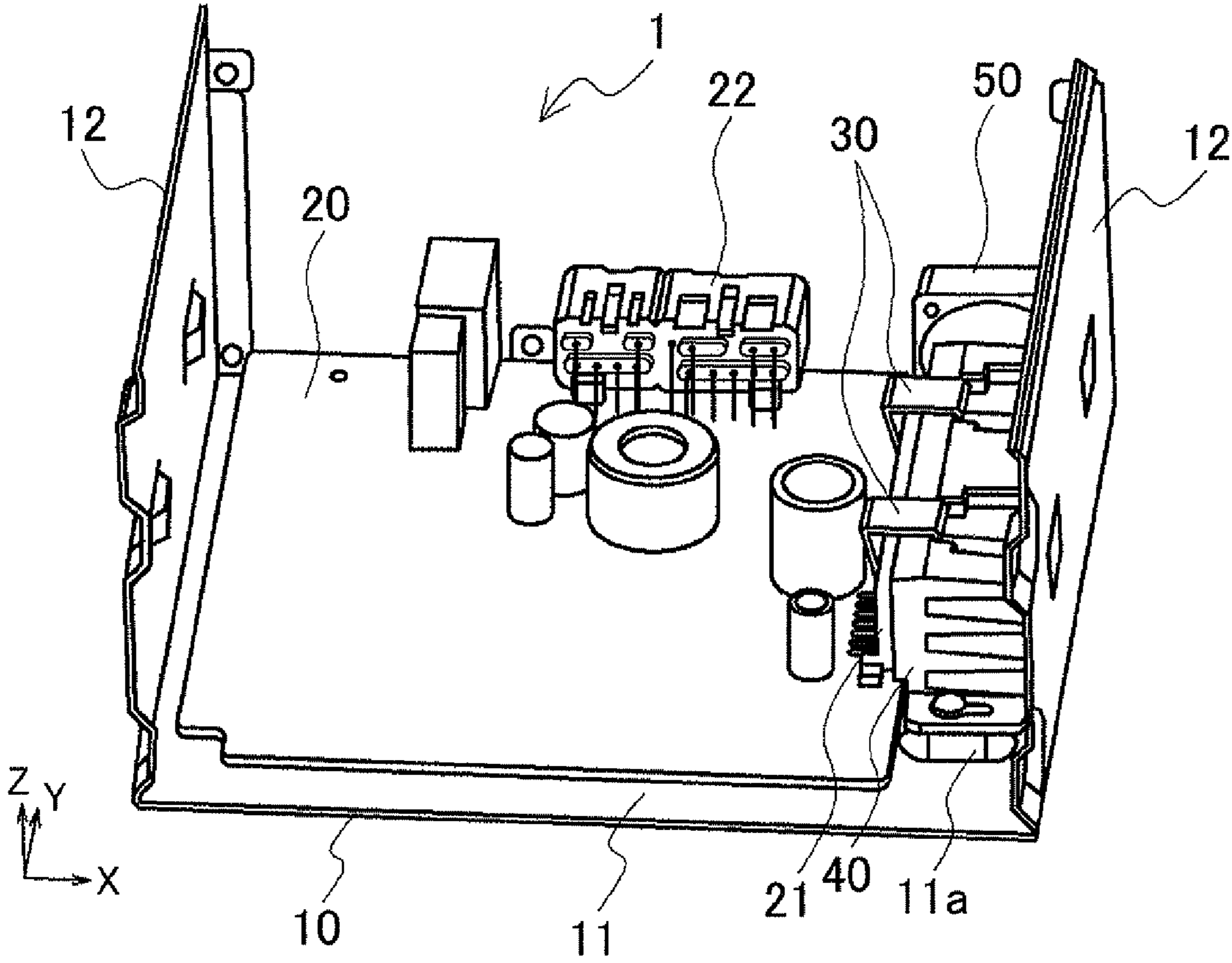


FIG. 2B

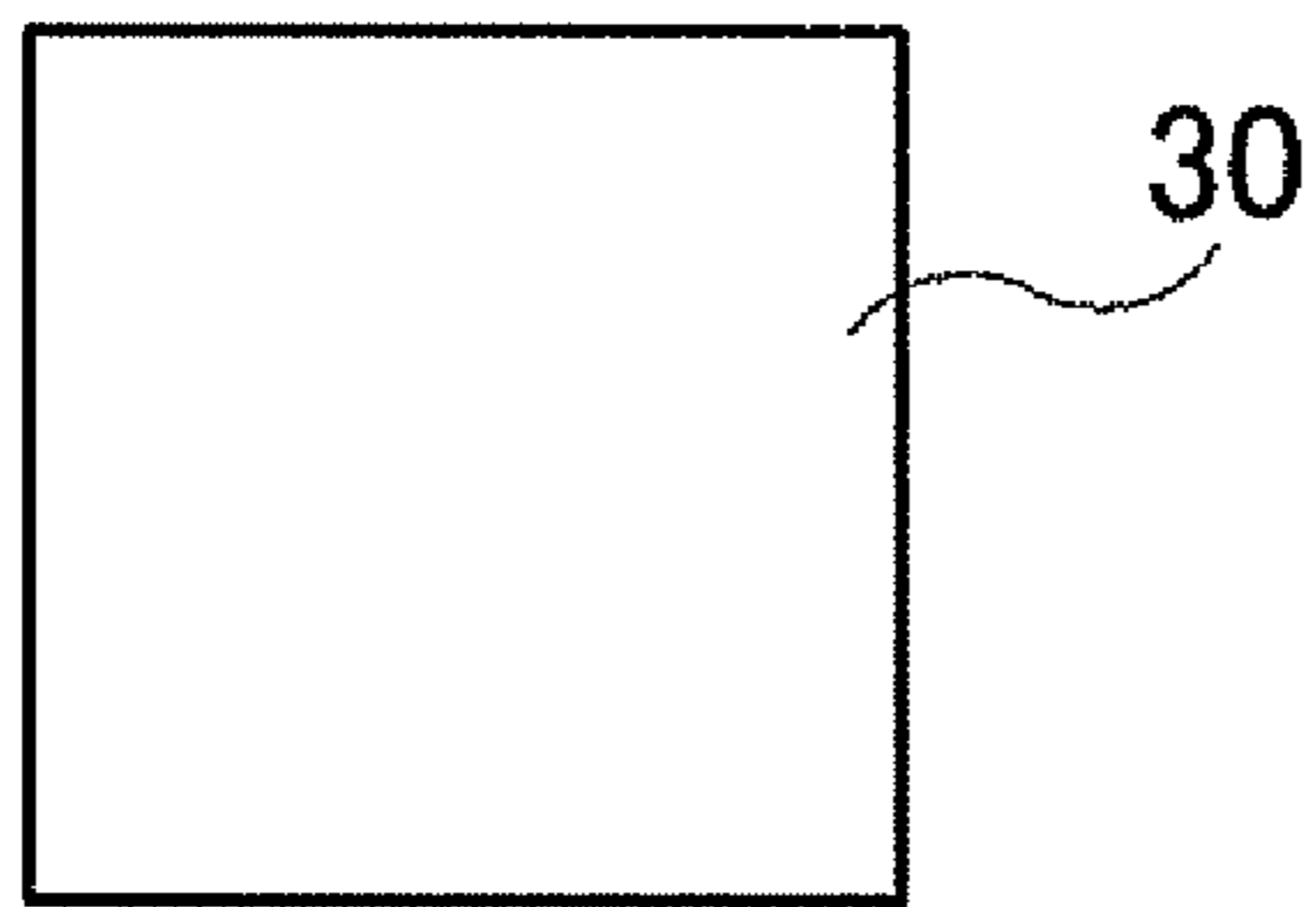


FIG. 2A

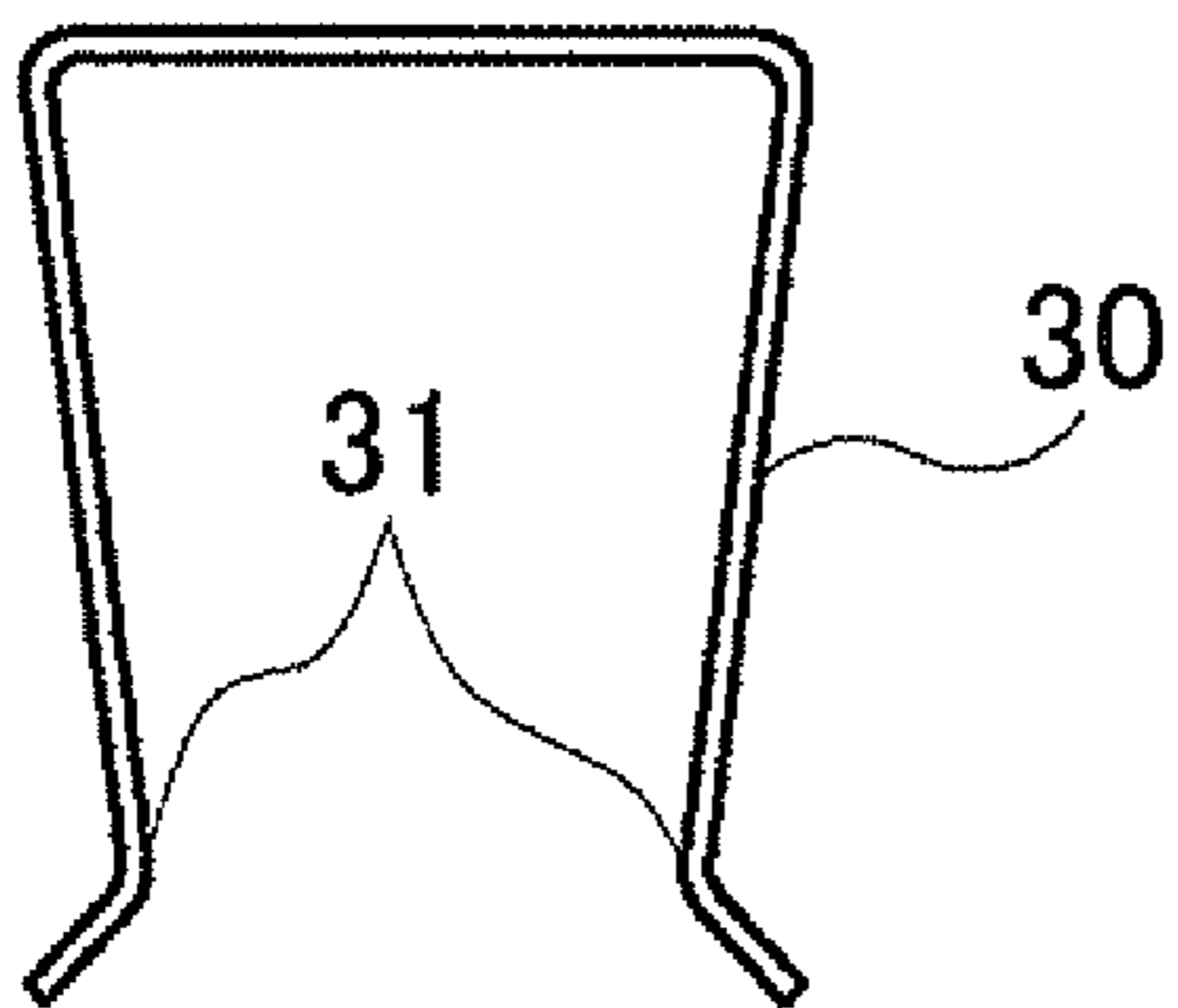


FIG. 2C

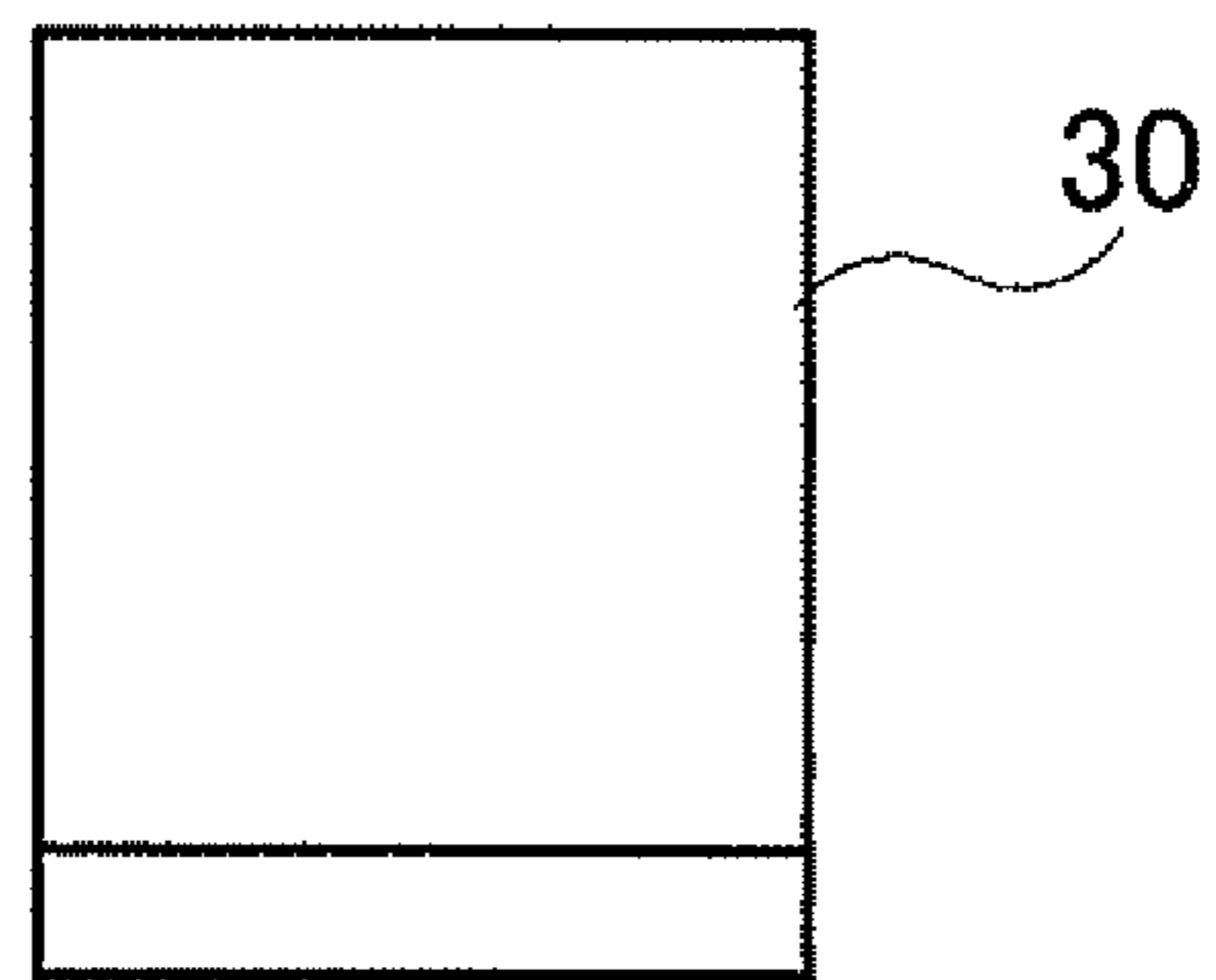


FIG. 3B

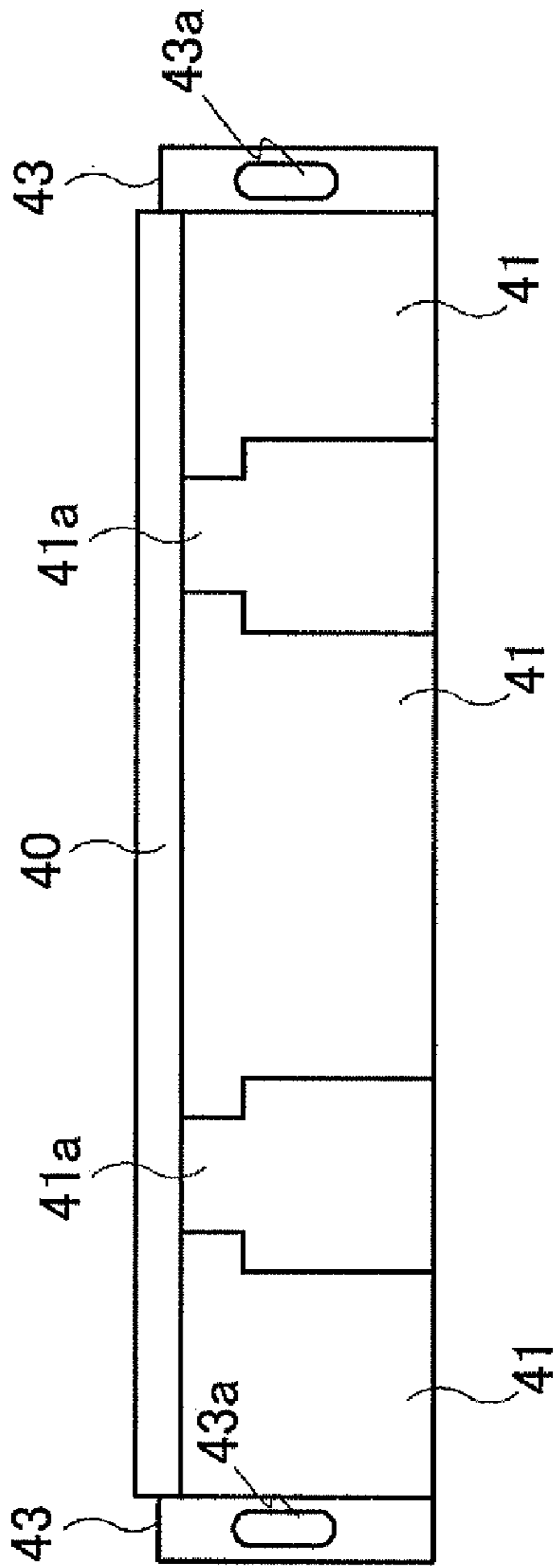


FIG. 3A

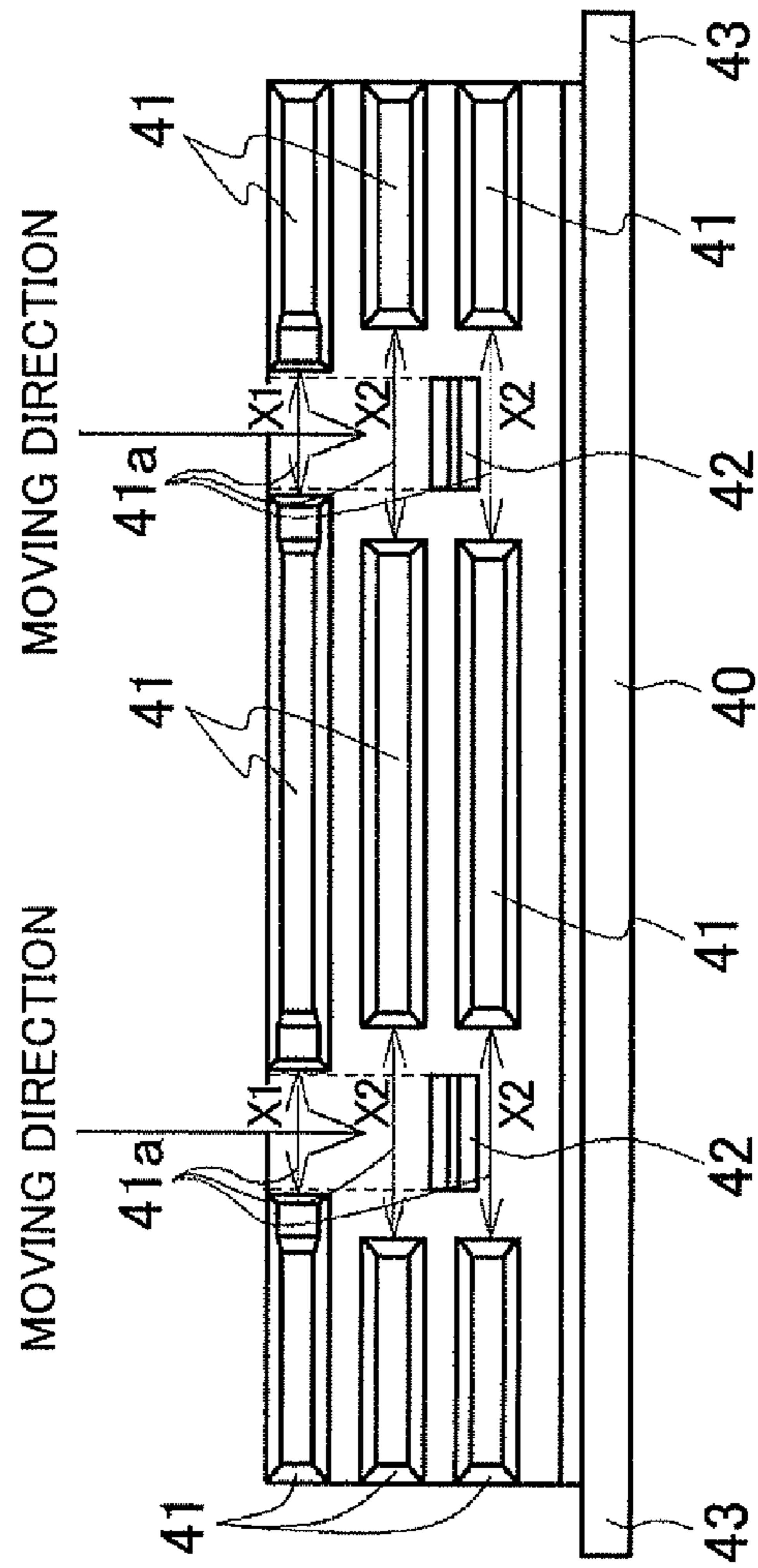


FIG. 3C

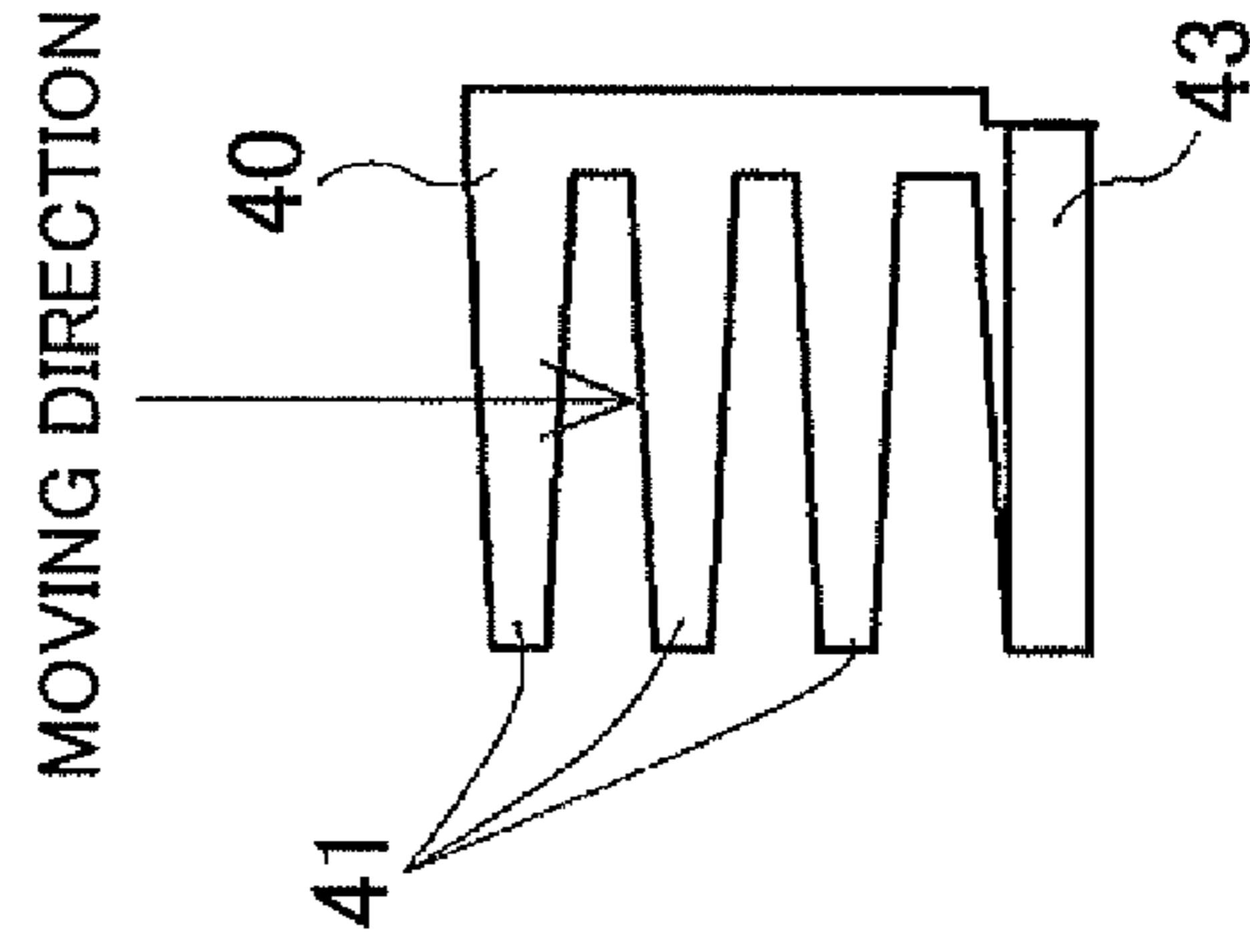


FIG. 4A

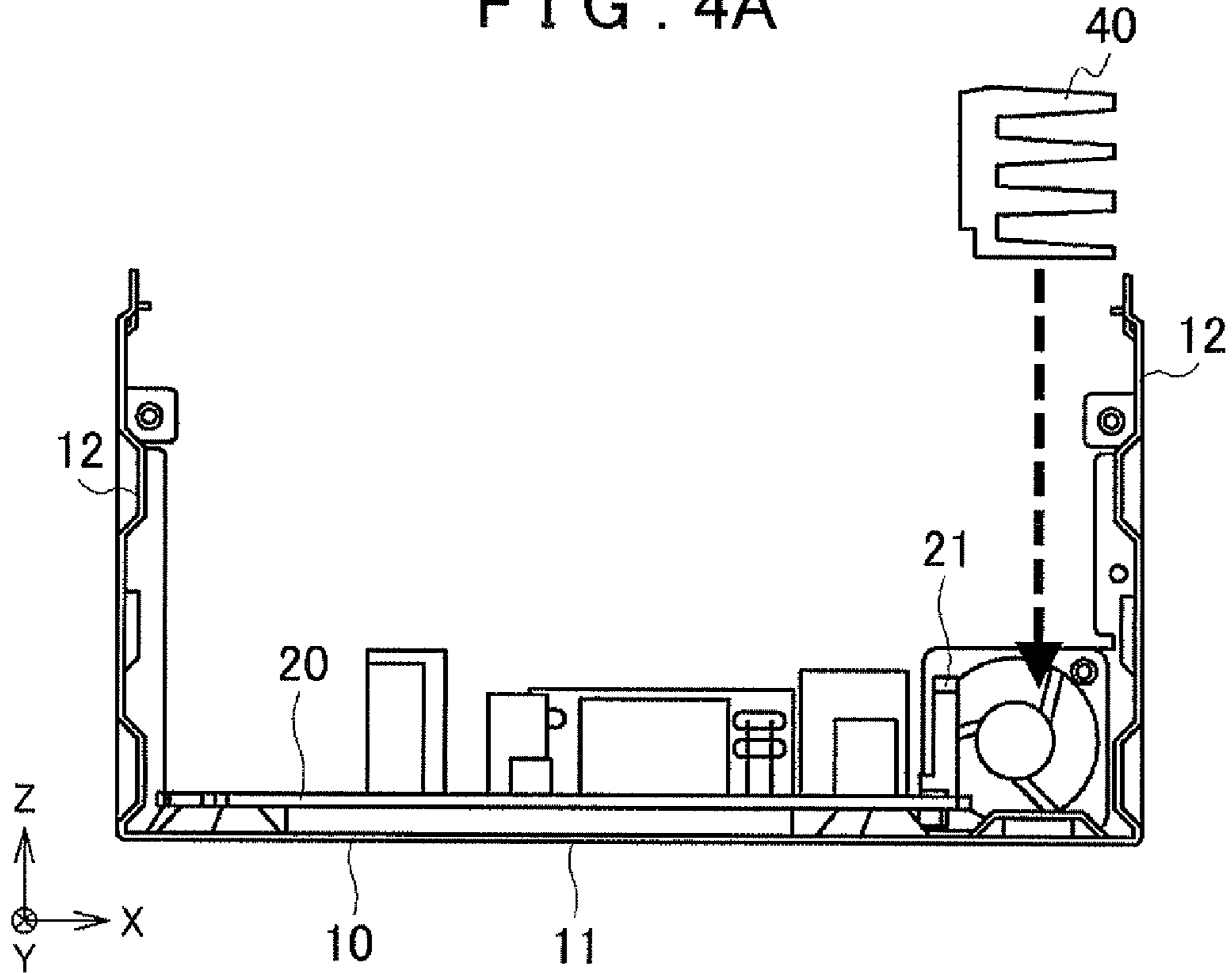


FIG. 4B

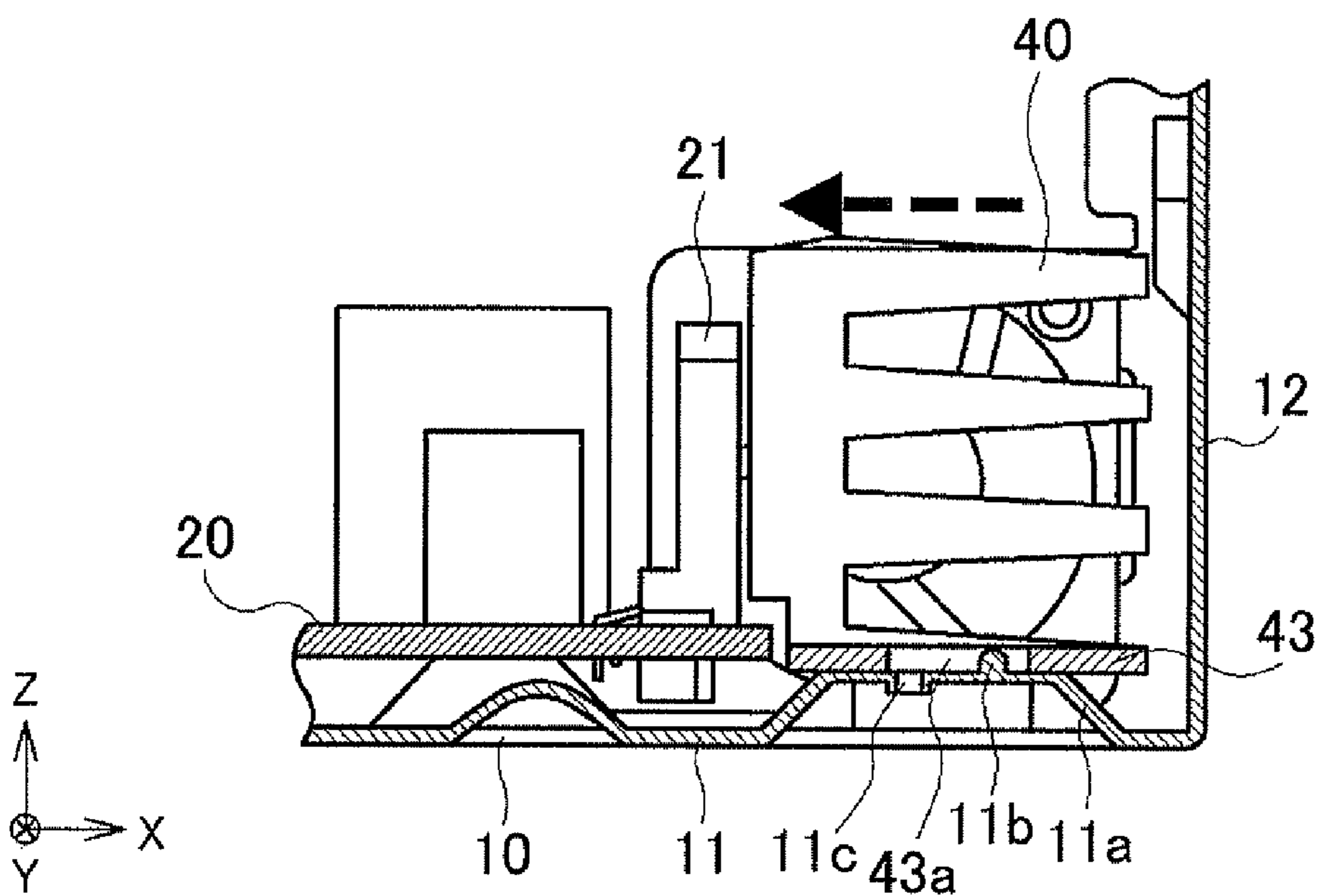


FIG. 5A

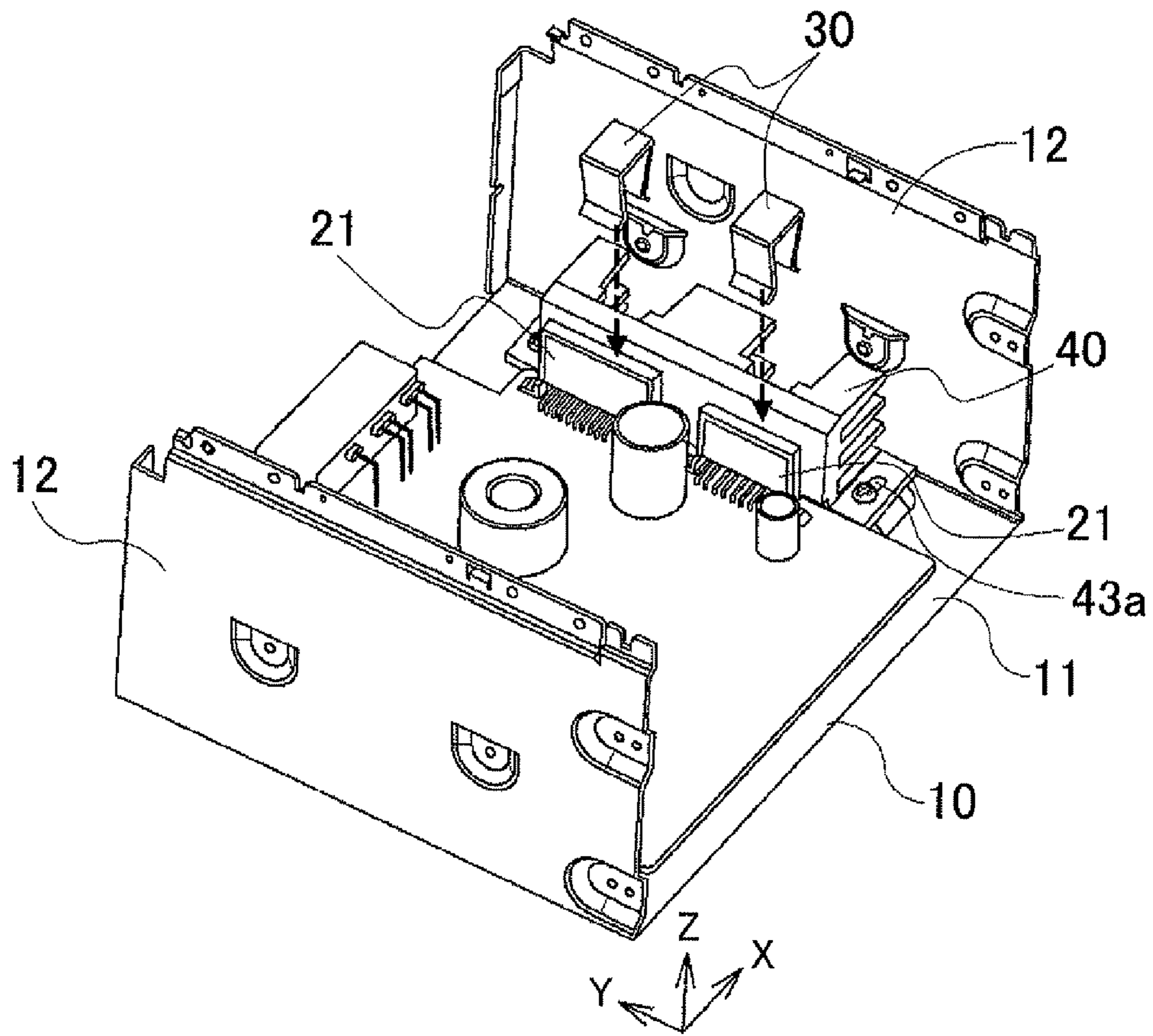


FIG. 5B

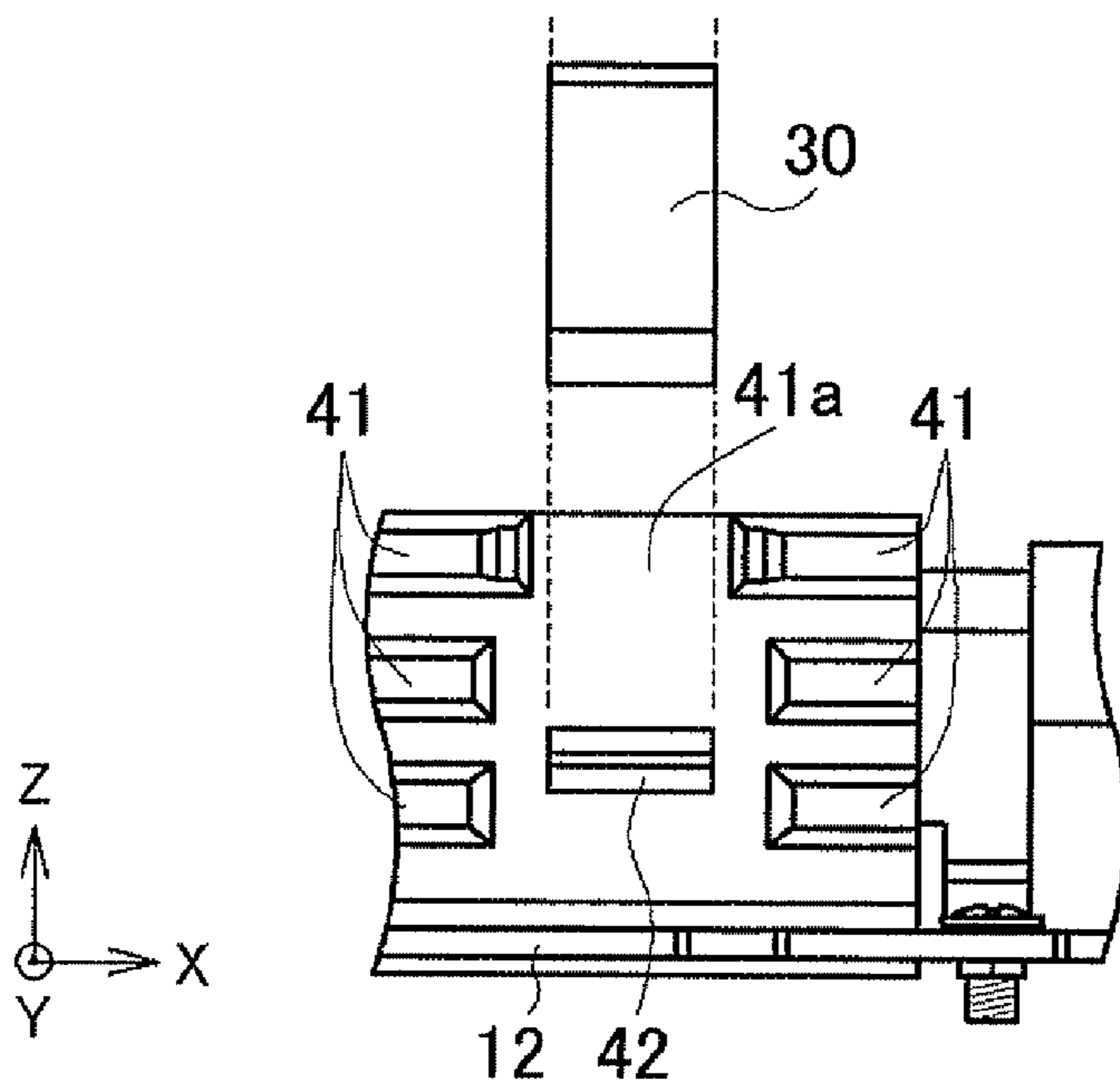
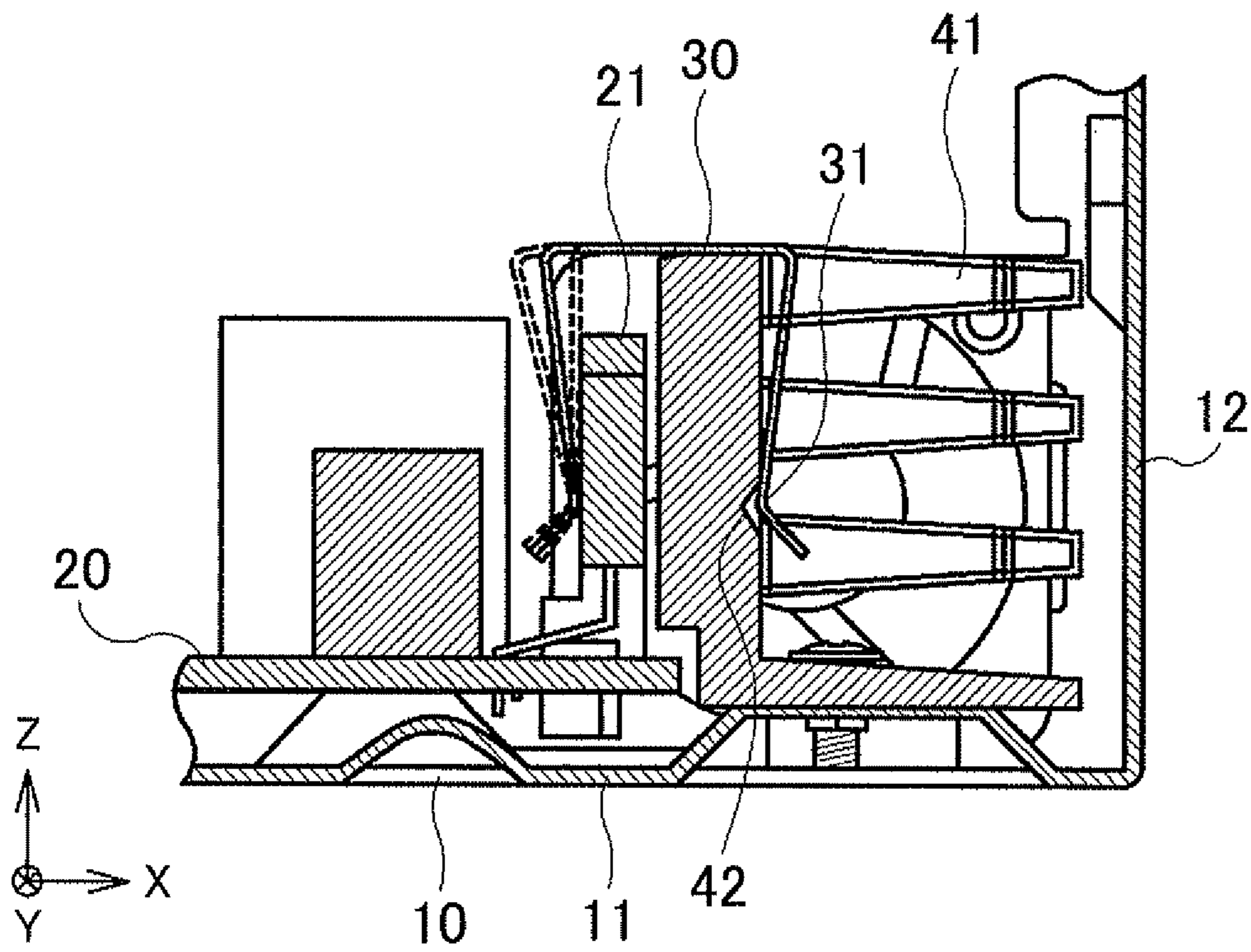


FIG. 6



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**FIXING STRUCTURE FOR HEAT SOURCE
ELEMENT AND HEAT CONDUCTING
MEMBER, AND METHOD OF FIXING HEAT
SOURCE ELEMENT AND HEAT
CONDUCTING MEMBER**

INCORPORATION BY REFERENCE

The disclosure of Japanese Patent Application No. 2010-268838, filed on Dec. 1, 2010, including the specification, drawings, and abstract is incorporated herein by reference in its entirety.

BACKGROUND

1. Related Technical Fields

Related technical fields include fixing structures for fixing a heat source element and a heat conducting member, and methods of fixing a heat source element and a heat conducting member.

2. Related Art

A heat source element such as an amplifier IC and a power regulator is mounted on an audio circuit board used in car navigation systems, for example. In recent years, in particular, the amount of heat generated by the heat source element has been increasing along with an increase in output produced by the heat source element, and thus it has been desired to take appropriate measures against heat.

A heat radiating structure for an electronic device that brings a heat source element into press contact with a heat sink for heat radiation using a bracket is proposed, for example. In this structure, an engagement piece provided on the bracket which supports the heat source element is inserted into a notch provided in the heat sink. A pressing engagement portion provided in the notch draws the engagement piece of the bracket to draw the heat source element toward the heat sink via the bracket (see Japanese Patent Application Publication No. JP-A-2003-229522, for example).

SUMMARY

In order to radiate heat generated by the heat source element such as an amplifier IC and a power regulator using a heat conducting member such as the heat sink, it is necessary to securely fix the heat source element to the heat conducting member such as the heat sink. In this case, respective contact surfaces of the heat source element and the heat sink may vary in position because of the dimensional tolerance and the assembly tolerance of the heat source element and the heat sink. Therefore, it is required that the fixing structure for the heat source element and the heat conducting member should be able to securely fix the heat source element and the heat sink by absorbing such variations, and that the fixing work should be performed easily. In the structure according to the related art discussed above, however, the heat source element and the heat sink must be brought into press contact with each other by fixing the bracket to the heat source element mounted on the audio circuit board and further to the heat sink, and thus the fixing work is troublesome. In addition, in order to correctly insert the engagement piece of the bracket into the notch provided in the heat sink, the heat source element, the bracket, and the heat sink must be installed at their respective correct positions, and thus the positioning work is also troublesome. Further, in the case where a plurality of heat source elements are provided, it is necessary to consider the dimensional tolerance and the assembly tolerance for each of the heat source elements as discussed above. Therefore, each

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of the heat source elements must be attached to the heat sink using a bracket that enables individual position adjustment for the heat source element, which may further complicate the fixing work.

Exemplary implementations of the broad inventive principles described herein provide a fixing structure for a heat source element and a heat conducting member and a method of fixing a heat source element and a heat conducting member that allow easy and secure fixation of the heat source element and the heat conducting member while absorbing variations in fixing position due to the dimensional tolerance and the assembly tolerance of the heat source element and the heat conducting member.

According to exemplary implementations, the heat conducting member is moved toward the heat source element along a direction that is generally orthogonal to a surface of the heat conducting member for abutment with the heat source element to be brought into abutment with the heat source element; and the heat source element and the heat conducting member, which have been brought into abutment with each other, are held by an elastic member to fix the heat source element and the heat conducting member to each other. Thus, it is possible to securely fix the heat source element and the heat conducting member to each other through easy work including holding the heat source element and the heat conducting member with the elastic member, while absorbing variations in fixing position due to the dimensional tolerance and the assembly tolerance of the heat source element and the heat conducting member through deformation of the elastic member.

According to exemplary implementations, the heat source element may be mounted on a circuit board such that a surface of the heat source element for abutment with the heat conducting member extends generally in parallel with a side surface portion of a housing; and the elastic member may be moved toward the heat source element and the heat conducting member along a direction that is generally orthogonal to a bottom surface portion to be disposed at a position at which the elastic member holds the heat source element and the heat conducting member. Thus, in order to place the elastic member at its holding position, the elastic member can be provided into the housing along the direction that is generally orthogonal to the bottom surface portion, and there is no need to perform work from directions other than the direction that is generally orthogonal to the bottom surface portion. Thus, the heat source element and the heat conducting member can be fixed to each other through simple and easy working procedures.

According to exemplary implementations, the heat conducting member may include a heat radiating fin extending generally orthogonally to a direction in which the elastic member is moved to be disposed at the position at which the elastic member holds the heat source element and the heat conducting member; and the heat radiating fin may be provided with a notched portion extending along the moving direction of the elastic member and having a width that is larger than a width of the elastic member. Thus, the heat source element and the heat conducting member can be securely fixed to each other by the elastic member while improving the heat radiation capability through the heat radiating fin.

According to exemplary implementations, the notched portion provided in the heat radiating fin, of a plurality of the heat radiating fins, that is first approached by the elastic member when the elastic member is moved toward the position at which the elastic member holds the heat source element and the heat conducting member may have a width that

is smaller than a width of the notched portions in the other heat radiating fins. Thus, portions that surround the notched portions of the heat radiating fin that is first approached by the elastic member restrict movement of the elastic member in directions other than the moving direction of the elastic member. In addition, the elastic member is prevented from being caught by the heat radiating fins other than the heat radiating fin that is first approached by the elastic member. Thus, the elastic member can be disposed at its holding position easily.

According to exemplary implementations, the elastic member may include a projection that is brought into abutment with the heat conducting member with the elastic member holding the heat source element and the heat conducting member; and the heat conducting member may include a recess provided in the notched portion to be fitted with the projection. Thus, the elastic member can be disposed at an appropriate position easily and securely.

According to exemplary implementations, a plurality of the heat source elements may be mounted on the circuit board, and the plurality of the heat source elements and the single heat conducting member may be brought into abutment with other. Thus, the plurality of the heat source elements can be fixed to the heat conducting member easily with no need to individually position a plurality of the heat source elements and a plurality of the heat conducting members with respect to each other.

According to exemplary implementations, the elastic member may be movable in a range in which there are no terminals of the heat source element for connection with the circuit board or no elements mounted on the circuit board other than the heat source element. Thus, variations in fixing position due to the dimensional tolerance and the assembly tolerance of the heat source element and the heat conducting member can be absorbed through movement of the elastic member while preventing the elastic member from contacting the elements other than the heat source element or the connection terminals of the heat source element.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an audio device;

FIGS. 2A, 2B and 2C are views showing a clip according to the example as viewed from three directions, in which FIGS. 2A, 2B, and 2C are a front view, a plan view, and a side view, respectively, of the clip;

FIGS. 3A, 3B and 3C are views showing a heat sink according to the example as viewed from three directions, in which FIGS. 3A, 3B, and 3C are a front view, a plan view, and a side view, respectively, of the heat sink;

FIGS. 4A and 4B are views illustrating an abutting process in which heat source elements and the heat sink are brought into abutment with each other, in which FIG. 4A is a side cross-sectional view showing a process in which the heat sink is accommodated in a housing, and FIG. 4B is an enlarged side cross-sectional view showing a process in which the heat source elements and the heat sink are brought into abutment with each other;

FIGS. 5A and 5B are views illustrating a fixing process in which the heat source elements and the heat sink are fixed to each other, in which FIG. 5A is a perspective view showing a process in which clips are moved toward the heat source elements and the heat sink, and FIG. 5B is an enlarged side view showing the process in which the clips are moved toward the heat source elements and the heat sink; and

FIG. 6 is an enlarged side cross-sectional view showing a state after the fixing process is performed.

DETAILED DESCRIPTION OF EXEMPLARY IMPLEMENTATIONS

A fixing structure for a heat source element and a heat conducting member and a method of fixing a heat source element and a heat conducting member will be described in detail below with reference to the drawings. The fixing structure for a heat source element and a heat conducting member and the method of fixing a heat source element and a heat conducting member may be applied to any electronic device such as a navigation device and an audio device installed in an automobile, for example. In the example, the fixing structure for a heat source element and a heat conducting member and the method of fixing for a heat source element and a heat conducting member are applied to an audio device.

I. CONFIGURATION

First, the basic configuration of the audio device will be described. FIG. 1 is a perspective view of the audio device. As shown in FIG. 1, the audio device 1 includes a housing 10, a circuit board 20, clips 30 (elastic members), a heat sink 40 (heat conducting member), and a fan 50.

A. Housing

The housing 10 includes a bottom surface portion 11 and side surface portions 12 extending generally orthogonally to the bottom surface portion 11. The bottom surface portion 11 and the side surface portions 12 are formed by pressing a single steel sheet, for example. A flange fixing portion 11a for fixation of flange portions 43 of the heat sink 40 to be discussed later is provided on the bottom surface portion 11 at a position corresponding to the flange portions 43. The flange fixing portion 11a is provided with projecting portions 11b to be inserted into long holes 43a provided in the flange portions 43 of the heat sink 40, and screw holes 11c that receive screws (not shown) for fixing the heat sink 40 to the bottom surface portion 11. After various components are accommodated inside the housing 10, a cover (not shown) that covers an open portion of the housing 10 is attached to separate the inside of the housing 10 from the outside thereof.

B. Circuit Board

The circuit board 20 is a printed wiring circuit board fixed to the housing 10 so as to extend generally in parallel with the bottom surface portion 11 of the housing 10. The circuit board 20 is accommodated in the housing 10. Various components such as heat source elements 21 that generate heat when energized to serve as heat sources such as an amplifier IC and a power regulator, a capacitor, a resistor, a coil, and a vehicle connector 22, for example, are mounted on the circuit board 20. The heat source elements 21 are mounted on the circuit board 20 with surfaces of the heat source elements 21 for abutment with the heat sink 40 extending generally in parallel with the side surface portion 12 of the housing 10. In the example of FIG. 1, two heat source elements 21 are disposed side by side at an end portion of the circuit board 20 on the +X side. The two heat source elements 21 are mounted on the circuit board 20 with a surface of each of the heat source elements 21 for abutment with the heat sink 40 (in FIG. 1, the surface on the +X side) extending generally in parallel with the side surface portion 12 of the housing 10 on the +X side. A connector (not shown) of a connection cable for mutual connection between the audio device 1 and other in-vehicle devices such as a navigation device is inserted into the vehicle connector 22.

C. Clip

The clips **30** are each an elastic member that holds the heat source element **21** and the heat sink **40** to fix the heat source element **21** and the heat sink **40** to each other. FIGS. **2A**, **2B** and **2C** are views showing the clip **30** according to the example as viewed from three directions. FIG. **2A** is a front view of the clip **30**. FIG. **2B** is a plan view of the clip **30**. FIG. **2C** is a side view of the clip **30**. As shown in FIGS. **2A**, **2B** and **2C**, the clip **30** is formed from an elastic material such as a steel sheet, and formed to have a generally U-shaped cross section. The heat source element **21** and the heat sink **40** are held between both end portions of the clip **30** to be fixed to each other by an elastic force of the clip **30**. As shown in FIG. **2A**, the clip **30** includes projections **31** that are brought into abutment with the heat source element **21** and the heat sink **40** with the clip **30** holding the heat source element **21** and the heat sink **40**.

D. Heat Sink

Returning to FIG. **1**, the heat sink **40** is a heat conducting member that radiates heat generated by the heat source elements **21** to a different place. The heat sink **40** is accommodated in the housing **10**. The heat sink **40** may be formed from a material with a high heat conductivity such as aluminum and copper, for example. A heat conducting plate, a heat pipe, or the like that transfers heat to a heat radiating portion provided at a different location may be used as a heat conducting member in place of the heat sink **40**. In the example, the heat sink **40** including a plurality of heat radiating fins **41** is used as the heat conducting member.

FIGS. **3A**, **3B** and **3C** are views showing the heat sink **40** according to the example as viewed from three directions. FIG. **3A** is a front view of the heat sink **40**. FIG. **3B** is a plan view of the heat sink **40**. FIG. **3C** is a side view of the heat sink **40**. As shown in FIGS. **3A**, **3B** and **3C**, the heat sink **40** includes the plurality of heat radiating fins **41**, recesses **42**, and the flange portions **43**. The heat sink **40** is formed to have at least such a length that enables the heat sink **40** to be brought into abutment with both the two heat source elements **21** mounted on the circuit board **20**.

The heat radiating fins **41** are formed as generally flat plates extending generally orthogonally to the direction (direction of the arrows in FIGS. **3A** and **3C**) in which the clips **30** are moved toward positions at which the clips **30** hold the heat source elements **21** and the heat sink **40** (hereinafter referred to as "holding positions" as necessary). Each of the heat radiating fins **41** is provided with notched portions **41a** provided along the direction in which the clips **30** are moved toward their holding positions and having a width that is larger than the width of the clips **30** (indicated by the dotted lines in FIG. **3A**). The number of the notched portions **41a** corresponds to the number of the clips **30** used (in FIGS. **3A** and **3B**, each of the heat radiating fins **41** is provided with two notched portions **41a**). Of the notched portions **41a** provided in the heat radiating fins **41**, the notched portions **41a** provided in the heat radiating fin **41** that is first approached by the clips **30** when the clips **30** are moved toward their holding positions (in FIGS. **3A** and **3C**, the uppermost heat radiating fin **41**) are formed to have a width $x1$ that is smaller than the width $x2$ of the notched portions **41a** in the other heat radiating fins **41**. More particularly, the width $x1$ of the notched portion **41a** provided in the heat radiating fin **41** that is first approached by the clips **30** when the clips **30** are moved toward their holding positions is formed such that the difference between the width $x1$ and the width of the clips **30** is minimized, and specifically formed to be larger than the maximum allowable width of the clips **30** by a predetermined width (for example, 1 mm). Meanwhile, the width $x2$ of the

notched portions **41a** provided in the other heat radiating fins **41** is formed to be sufficiently larger than the width of the clips **30**, and specifically formed to be larger than the width $x1$ of the notched portions **41a** provided in the heat radiating fin **41** that is first approached by the clips **30** by a predetermined width (for example, 5 mm). As a result, portions that surround the notched portions **41a** of the heat radiating fin **41** that is first approached by the clips **30** when the clips **30** are moved toward their holding positions restrict movement of the clips **30** in directions other than the moving direction of the clips **30** (for example, the left and right directions in FIG. **3A**). In addition, the clips **30** are prevented from being caught by the other heat radiating fins **41**. Thus, the heat source elements **21** and the heat sink **40** can be held by the clips **30** with improved assembly efficiency.

The recesses **42** are to be fitted with the projections **31** of the clips **30**. As shown in FIG. **3A**, the recesses **42** are formed in a surface of the heat sink **40** on which the heat radiating fins **41** are provided at positions corresponding to the projections **31** of the clips **30**. The recesses **42** are formed to be wider than the projections **31** of the clips **30**.

The flange portions **43** serve as portions to be fixed when the heat sink **40** is fixed to the bottom surface portion **11** of the housing **10**. The flange portions **43** are respectively provided at both ends of the heat sink **40** on the bottom surface portion **11** side. As shown in FIG. **3B**, the long holes **43a** are formed in the flange portions **43**. When installing the heat sink **40** on the bottom surface portion **11** of the housing **10**, the projecting portions **11b** of the flange fixing portion **11a** are inserted into the long holes **43a**, and the screws for fixing the heat sink **40** to the bottom surface portion **11** are screwed into the screw holes **11c** of the flange fixing portion **11a** via the long holes **43a**.

A surface of the heat sink **40** that is opposite the surface provided with the heat radiating fins **41** is formed as a flat surface for abutment with the heat source elements **21**.

E. Fan

Returning to FIG. **1**, the fan **50** forcibly supplies an air flow to the surfaces of the heat radiating fins **41** to promote heat radiation from the heat radiating fins **41**. The fan **50** is accommodated in the housing **10**. In the example, as shown in FIG. **1**, in order to generate an air flow along the direction (in FIG. **1**, $-Y$ direction) that is generally in parallel with the heat radiating fins **41**, the fan **50** is disposed at a side of the heat sink **40** and at a position at which the fan **50** can discharge air inside the housing **10** out of the housing **10**.

II. METHOD OF FIXING HEAT SOURCE ELEMENT AND HEAT SINK

Next, the fixing structure for the heat source elements **21** and the heat sink **40** and the method of fixing the heat source elements **21** and the heat sink **40** in the thus configured audio device **1** will be described. In the following description, the circuit board **20** on which the heat source elements **21** are mounted and the fan **50** are already accommodated in the housing **10**.

A. Abutting Process

FIGS. **4A** and **4B** are views illustrating an abutting process in which the heat source elements **21** and the heat sink **40** are brought into abutment with each other. FIG. **4A** is a side cross-sectional view showing a process in which the heat sink **40** is accommodated in the housing **10**. FIG. **4B** is an enlarged side cross-sectional view showing a process in which the heat source elements **21** and the heat sink **40** are brought into abutment with each other. Before starting the abutting process, thermally conductive grease or a thermally conductive

sheet is applied to surfaces of the heat source elements **21** for abutment with the heat sink **40**, or a surface of the heat sink **40** for abutment with the heat source elements **21**.

First, as shown in FIG. **4A**, the heat sink **40** is moved toward the bottom surface portion **11** along the direction (the dotted arrow in FIG. **4A**) that is generally orthogonal to the bottom surface portion **11** to be accommodated in a space between the heat source elements **21** and the side surface portion **12**. The heat sink **40** is thus accommodated in the housing **10**. In this event, as shown in FIG. **4B**, the heat sink **40** is disposed such that the projecting portions **11b** of the flange fixing portion **11a** are inserted into the long holes **43a** of the flange portions **43**.

Subsequently, as shown in FIG. **4B**, the heat sink **40** accommodated in the housing **10** is moved toward the heat source elements **21** along the direction (the dotted arrow in FIG. **4B**) that is generally orthogonal to the surface of the heat sink **40** for abutment with the heat source elements **21**. The heat source elements **21** and the heat sink **40** are thus brought into abutment with each other. In the example, two heat source elements **21** are mounted on the circuit board **20**, and a single heat sink **40** is brought into abutment with the two heat source elements **21**. As discussed above, the projecting portions **11b** of the flange fixing portion **11a** are inserted into the long holes **43a** of the flange portions **43**. Therefore, the heat sink **40** can be moved only along the longitudinal direction of the long holes **43a** (that is, the direction that is generally orthogonal to the surface of the heat sink **40** for abutment with the heat source elements **21**) while keeping the surface of the heat sink **40** for abutment with the heat source elements **21** (the surface on the $-X$ side in FIG. **4A**) and the surfaces of the heat source elements **21** for abutment with the heat sink **40** (the surfaces on the $+X$ side in FIG. **4A**) generally in parallel with each other. The heat sink **40** can thus be positioned easily. After the heat source elements **21** and the heat sink **40** are brought into abutment with each other, screws (not shown) are screwed into the screw holes **11c** of the flange fixing portion **11a** via the long holes **43a** of the flange portions **43**. The heat sink **40** is thus fixed to the bottom surface portion **11**.

B. Fixing Process

FIGS. **5A** and **5B** are views illustrating a fixing process in which the heat source elements **21** and the heat sink **40** are fixed to each other. FIG. **5A** is a perspective view showing a process in which the clips **30** are moved toward the heat source elements **21** and the heat sink **40**. FIG. **5B** is an enlarged side view showing the process in which the clips **30** are moved toward the heat source elements **21** and the heat sink **40**. FIG. **6** is an enlarged side cross-sectional view showing a state after the fixing process is performed.

As shown in FIGS. **5A** and **5B**, the clips **30** are moved toward the heat source elements **21** and the heat sink **40**, which have been brought into abutment with each other in the abutting process, along the direction (in FIGS. **5A** and **5B**, Z direction) that is generally orthogonal to the bottom surface portion **11**. The clips **30** are thus disposed at positions at which the clips **30** hold the heat source elements **21** and the heat sink **40**. In the example, two heat source elements **21** and a single heat sink **40** have been brought into abutment with each other in the abutting process. Thus, as shown in FIG. **5A**, a single clip **30** is disposed for each of the two heat source elements **21**. When moving the clips **30** toward their holding positions, as shown in FIG. **5B**, the portions that surround the notched portions **41a** of the heat radiating fin **41** that is first approached by the clips **30** restrict movement of the clips **30** in directions (in FIG. **5B**, Y direction, for example) other than the moving direction of the clips **30**. Thus, the clips **30** can be

disposed at appropriate positions. Further, the notched portions **41a** provided in the heat radiating fin **41** that is first approached by the clips **30** are formed to have a width that is smaller than the width of the notched portions **41a** in the other heat radiating fins **41**. Thus, the clips **30** are prevented from being caught by the heat radiating fins **41** other than the heat radiating fin **41** that is first approached by the clips **30** when the clips **30** are moved toward their holding positions. Thus, the clips **30** can be disposed at their holding positions easily. The clips **30** can be disposed at their holding positions by moving the clips **30** until the projecting portions **31** of the clips **30** are fitted with the recesses **42** of the heat sink **40** as shown in FIG. **6**. This allows the heat source elements **21** and the heat sink **40** to be fixed to each other through the elastic force of the clips **30**.

Variations in fixing position due to the dimensional tolerance and the assembly tolerance of the heat source elements **21** and the heat sink **40** are absorbed through deformation of the clips **30**. The heat source elements **21** and the heat sink **40** may be subjected to dimensional variations due to temperature variations, and may receive an external force due to vibration. Even in such cases, an elastic force is applied from the clips **30** to the heat source elements **21** and the heat sink **40** at all times to securely keep the heat source elements **21** and the heat sink **40** in the fixed state. When or after the clips **30** are moved to their holding positions, the clips **30** may be displaced or deformed because of play between the projections **31** of the clips **30** and the recesses **42** of the heat sink **40**, for example, to move the end portions of the clips **30**. As indicated by the dotted lines in FIG. **6**, however, the clips **30** are movable in a range in which there are no elements mounted on the circuit board **20** other than the heat source elements **21** or no connection terminals of the heat source elements **21**. Thus, the end portions of the clips **30** will not contact such connection terminals to cause a short circuit or the like.

As discussed above, both in the case where the heat sink **40** is accommodated in the housing **10** in the abutting process and in the case where the clips **30** are disposed at their holding positions in the fixing process, the heat sink **40** and the clips **30** can be provided into the housing **10** from an opening portion of the housing **10** along the direction that is generally orthogonal to the bottom surface portion **11**, and there is no need to perform work from directions other than the direction that is generally orthogonal to the bottom surface portion **11**. Thus, the heat source elements **21** and the heat sink **40** can be fixed to each other through simple and easy working procedures. In particular, even in the case where the side surface portions **12** extending generally orthogonally to the bottom surface portion **11** make it difficult to perform work from directions other than the direction that is generally orthogonal to the bottom surface portion **11** as in the example, the heat sink **40** and the clips **30** can be disposed in the housing **10** easily to achieve a remarkable effect that the heat source elements **21** and the heat sink **40** can be fixed to each other easily.

III. EFFECTS

According to the example described above, the heat sink **40** is moved toward the heat source elements **21** along the direction that is generally orthogonal to the surface of the heat sink **40** for abutment with the heat source elements **21** to be brought into abutment with the heat source elements **21**, and the heat source elements **21** and the heat sink **40**, which have been brought into abutment with each other, are held by the clips **30** to fix the heat source elements **21** and the heat sink **40**

to each other. Thus, it is possible to securely fix the heat source elements **21** and the heat sink **40** to each other through easy work including holding the heat source elements **21** and the heat sink **40** with the clips **30**, while absorbing variations in fixing position due to the dimensional tolerance and the assembly tolerance of the heat source elements **21** and the heat sink **40** through deformation of the clips **30**.

The heat source elements **21** are mounted on the circuit board **20** such that the surfaces of the heat source elements **21** for abutment with the heat sink **40** extend generally in parallel with the side surface portions **12** of the housing **10**, and the clips **30** are moved toward the heat source elements **21** and the heat sink **40** along the direction that is generally orthogonal to the bottom surface portion **11** to be disposed at positions at which the clips **30** hold the heat source element **21** and the heat sink **40**. Thus, in order to place the clips **30** at their holding positions, the clips **30** can be provided into the housing **10** along the direction that is generally orthogonal to the bottom surface portion **11**, and there is no need to perform work from directions other than the direction that is generally orthogonal to the bottom surface portion **11**. Thus, the heat source elements **21** and the heat sink **40** can be fixed to each other through simple and easy working procedures.

The heat sink **40** includes the heat radiating fins **41** extending generally orthogonally to the direction in which the clips **30** are moved toward positions at which the clips **30** hold the heat source elements **21** and the heat sink **40**. Each of the heat radiating fins **41** is provided with the notched portions **41a** provided along the moving direction of the clips **30** and having a width that is larger than the width of the clips **30**. Thus, the heat source elements **21** and the heat sink **40** can be securely fixed to each other by the clips **30** while improving the heat radiation capability through the heat radiating fins **41**.

Of the notched portions **41a** provided in the plurality of heat radiating fins **41**, the notched portions **41a** provided in the heat radiating fin **41** that is first approached by the clips **30** when the clips **30** are moved toward positions at which the clips **30** hold the heat source elements **21** and the heat sink **40** have a width that is smaller than the width of the notched portions **41a** in the other heat radiating fins **41**. Thus, the portions that surround the notched portions **41a** of the heat radiating fin **41** that is first approached by the clips **30** restrict movement of the clips **30** in directions other than the moving direction of the clips **30**. In addition, the clips **30** are prevented from being caught by the heat radiating fins **41** other than the heat radiating fin **41** that is first approached by the clips **30**. Thus, the clips **30** can be disposed at their holding positions easily.

The clips **30** include the projections **31** that are brought into abutment with the heat sink **40** with the clips **30** holding the heat source elements **21** and the heat sink **40**, and the heat sink **40** includes the recesses **42** provided in the notched portions **41a** to be fitted with the projections **31**. Thus, the clips **30** can be disposed at appropriate positions easily and securely.

A plurality of heat source elements **21** are mounted on the circuit board **20**, and the plurality of heat source elements **21** and the single heat sink **40** are brought into abutment with each other. Thus, the plurality of heat source elements **21** can be fixed to the heat sink **40** easily with no need to individually position a plurality of heat source elements **21** and a plurality of heat sinks **40** with respect to each other.

The clips **30** are movable in a range in which there are no terminals of the heat source elements **21** for connection with the circuit board **20** or no elements mounted on the circuit board **20** other than the heat source elements **21**. Thus, variations in fixing position due to the dimensional tolerance and the assembly tolerance of the heat source elements **21** and the

heat sink **40** can be absorbed through movement of the clips **30** while preventing the clips **30** from contacting the elements other than the heat source elements **21** or the connection terminals of the heat source elements **21**.

IV. MODIFICATIONS

While various features have been described in conjunction with the examples outlined above, various alternatives, modifications, variations, and/or improvements of those features and/or examples may be possible. Accordingly, the examples, as set forth above, are intended to be illustrative. Various changes may be made without departing from the broad spirit and scope of the underlying inventive principles. The problem to be solved by the inventive principles described herein and the effects of those principles are not limited to those discussed above, and may differ in accordance with the environment in which the principles are implemented and the details of the configuration. Thus, only part of the problem discussed above may be solved, and only some of the effects discussed above may be yielded.

A. Heat Source Element

In the example discussed above, the heat source elements **21** are implemented by an amplifier IC, a power regulator, or the like. However, the heat source elements **21** can be implemented by other components such as a CPU, for example.

B. Heat Sink

In the example discussed above, the heat conducting member is implemented by the heat sink **40** including the plurality of heat radiating fins **41**. However, the heat conducting member may be implemented by a heat conducting plate, a heat pipe, or the like that transfers heat to a heat radiating portion provided at a different location. Also in this case, as in the example discussed above, the heat source elements **21** and the heat conducting plate, the heat pipe, or the like, which have been brought into abutment with each other, can be held by the clips **30** to fix the heat source elements **21** and the heat conducting plate, the heat pipe, or the like to each other easily and securely.

In the example discussed above, the heat radiating fins **41** are formed as generally flat plates extending generally orthogonally to the direction in which the clips **30** are moved toward positions at which the clips **30** hold the heat source elements **21** and the heat sink **40**. However, the heat radiating fins **41** may be provided to extend along a different direction. For example, the heat radiating fins **41** may be formed as generally flat plates extending generally in parallel with the direction in which the clips **30** are moved toward positions at which the clips **30** hold the heat source elements **21** and the heat sink **40**.

In the example discussed above, of the notched portions **41a** provided in the heat radiating fins **41**, the notched portions **41a** provided in the heat radiating fins **41** other than the heat radiating fin **41** that is first approached by the clips **30** when the clips **30** are moved toward their holding positions are all formed to have the same width. However, the notched portions **41a** provided in such heat radiating fins **41** may have different widths. For example, the notched portions **41a** provided in such heat radiating fins **41** may have widths that become larger in the order (from top to bottom in FIGS. 3A and 3C) of being approached by the clips **30** when the clips **30** are moved toward their holding positions.

C. Clip

In the example discussed above, the heat source elements **21** are fixed to the heat sink **40** using the separate clips **30**. However, a plurality of heat source elements **21** may be fixed

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to the heat sink 40 using a single clip 30. Alternatively, a single heat source element 21 may be fixed to the heat sink 40 using a plurality of clips 30.

D. Fan

In the example discussed above, the fan 50 is disposed at a side of the heat sink 40 and at a position at which the fan 50 can discharge air inside the housing 10 out of the housing 10. However, the fan 50 may be disposed at a side of the heat sink 40 and at a position at which the fan 50 can introduce air outside the housing 10 into the housing 10.

What is claimed is:

1. An electronic device mounted on a circuit board and accommodated in a housing, the electronic device comprising:

a heat source element accommodated in the housing and mounted on the circuit board;

a heat conducting member accommodated in the housing, the heat conducting member being movably mounted on the circuit board;

an elastic member fixing the heat source element and the heat conducting member in abutment with each other, the elasticity of the elastic member permitting variations in the relative positions of the heat source element and the heat conducting member while maintaining the abutment of the heat source element and the heat conducting member; and

a plurality of heat radiating fins provided on the heat conducting member, each of the plurality of heat radiating fins having a notched portion, each notched portion extending along an insertion direction in which the elastic member is inserted onto the heat conducting member, each notched portion having a width in a direction substantially perpendicular to the insertion direction that is larger than a width of the elastic member in the direction substantially perpendicular to the insertion direction, the width of a first notched portion provided in the heat radiating fin that is first approached by the elastic member when the elastic member is inserted onto the heat source element being smaller than the width of a second notched portion that is second approached by the elastic member when the elastic member is inserted onto the heat source.

2. The electronic device according to claim 1, wherein: the heat conducting member includes a recess provided in the notched portions; and

the elastic member includes a projection that is seated in the recess.

3. The electronic device according to claim 1, wherein: the heat conducting member includes a recess; and the elastic member includes a projection that is seated in the recess.

4. The electronic device according to claim 1, further comprising:

a plurality of the heat source elements mounted on the circuit board; and

a plurality of the elastic members, each elastic member fixing one of the plurality of the heat source elements and the heat conducting member in abutment with each other, the elasticity of each elastic member permitting variations in the relative positions of each heat source element and the heat conducting member while maintaining the abutment of each heat source element and the heat conducting member.

5. The electronic device according to claim 1, wherein: the elastic member is movable in a range in which there are no terminals of the heat source element for connection

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with the circuit board or no elements mounted on the circuit board other than the heat source element.

6. The electronic device according to claim 1, wherein the heat conducting member is a heat pipe.

7. The electronic device of claim 1, wherein the electronic device is an audio device.

8. The electronic device of claim 1, wherein the electronic device is a navigation device.

9. A method of fixing a heat source element and a heat conducting member that are mounted on a circuit board and accommodated in a housing, the method comprising:

moving the heat conducting member toward the heat source element;

abutting the heat conducting member against the heat source element; and

fixing the heat source element and the heat conducting member in abutment with each other with an elastic member, the elasticity of the elastic member permitting variations in the relative positions of the heat source element and the heat conducting member while maintaining the abutment of the heat source element and the heat conducting member;

wherein the heat conducting member includes a plurality of heat radiating fins, each of the plurality of heat radiating fins having a notched portion, each notched portion extending along an insertion direction in which the elastic member is inserted onto the heat conducting member, each notched portion having a width in a direction substantially perpendicular to the insertion direction that is larger than a width of the elastic member in the direction substantially perpendicular to the insertion direction, the width of a first notched portion provided in the heat radiating fin that is first approached by the elastic member when the elastic member is inserted onto the heat source element being smaller than the width of a second notched portion that is second approached by the elastic member when the elastic member is inserted onto the heat source.

10. The method of fixing the heat source element and the heat conducting member according to claim 9, further comprising moving the heat conducting member toward the heat source element along a direction that is generally perpendicular to an abutment surface of the heat conducting member.

11. The method of fixing the heat source element and the heat conducting member according to claim 9, wherein:

the housing includes a bottom surface portion;

the circuit board is fixed to the housing so as to extend generally parallel with the bottom surface portion;

the abutment surface extends generally perpendicular to the bottom surface portion; and

the method further comprises moving the elastic member toward the heat source element and the heat conducting member along a direction that is generally perpendicular to the bottom surface portion to fix the heat source element and the heat conducting member in abutment with each other.

12. The method of fixing the heat source element and the heat conducting member according to claim 9, wherein:

the heat conducting member includes a recess provided in the notched portions; and

the method further comprises seating a projection of the elastic member in the recess.

13. The method of fixing the heat source element and the heat conducting member according to claim 9, wherein:

the heat conducting member includes a recess; and

the method further comprises seating a projection of the elastic member in the recess.

- 14.** The method of fixing the heat source element and the heat conducting member according to claim **9**, wherein:
a plurality of the heat source elements are mounted on the circuit board; and
the method further comprises fixing each one of the plurality of the heat source elements and the heat conducting member in abutment with each other with one of a plurality of the elastic members, the elasticity of each elastic member permitting variations in the relative positions of each heat source element and the heat conducting member while maintaining the abutment of each heat source element and the heat conducting member.
- 15.** The method of fixing the heat source element and the heat conducting member according to claim **9**, wherein:
the elastic member is movable in a range in which there are no terminals of the heat source element for connection with the circuit board or no elements mounted on the circuit board other than the heat source element.
- 16.** The method of fixing the heat source element and the heat conducting member according to claim **9**, wherein the heat conducting member is a heat pipe.

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